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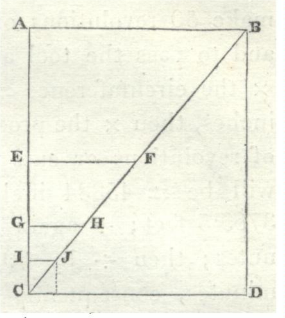
are so placed as to cause the sliding pieces of one part to lie over the filling-pieces of the other, and thus form a continued yet sliding band of metal round the piston. The points of the screws and heads of the steady pins in the filling pieces, and the edges of the springs *g*, are purposely kept a little below the surface, to prevent them from coming in contact with the opposite sliding pieces. Before the springs *g* are put in, the segments *f* and *h* are pushed in flush with *a* and *b*, and bound fast; the whole is then turned in the lathe together as one cylinder. The sliding and the filling pieces are perfectly flush or even with each other; but the circular prominences marked *a* in fig. 11, and *b* in figs. 10 and 15, project in the least possible degree beyond the segments, so that, when all the parts are bound together, the sliding pieces have just room, and no more, to move easily.

No. XII.

TURNING LATHE.

The GOLD ISIS MEDAL *was presented to Mr.* JAMES CLEMENT, 21, *Prospect Place, Southwark, for his improved Turning Lathe.*

IT is almost unnecessary to state, that persons who have been in the habit of turning different kinds of metal must be aware, that if it passes the tool at too great a velocity, it will soften and grind away the tool; consequently, lathes have been made with wheels, riggers, drums, &c. of different diameters, so as to alter the speed of the lathe mandril according to the hardness of the metal, and the diameter of the thing that is to be turned. For turning or boring cylinders, or any thing nearly of equal diameter, a uniform motion is all that is required, and, by the means of wheels, drums, riggers, &c. of different diameters working into each other, or by the motion of one communicated to the other by straps or bands, answers the purpose very well; but when a plane surface is required to be turned, the motion of the lathe mandril or the thing to be turned, ought to be diminished or increased in proportion as the tool is moved to and from the centre; then that part of the plane where the tool is applied would pass the tool always at the same velocity, and if a proper speed is obtained at the beginning, the tool will last for a considerable time without being much injured, and the surface will be very nearly perfect; but the motion of the lathe ought to be diminished or increased without stopping the lathe, otherwise the tool will make a mark or false cut on the surface, when the lathe is stopped to alter the motion. It may here be remarked, that if the motion of the lathe be at a proper speed, when the tool is at the greatest distance from the centre, and that the tool be made to advance towards the centre, and the lathe to continue at the same velocity, the tool would not be more injured when it arrives at the centre than if the velocity of the lathe or mandril were increased in proportion as the tool advanced towards the centre; this, it is acknowledged, would be the result, but then there would be a sacrifice of nearly one-half of the time, which is demonstrable by the annexed diagram.



Suppose the parallelogram A B C D to represent the time that would be required to turn a surface. Draw a diagonal line B C, bisect the line A C at E, E C at G, and G C at I, then draw the lines E F, G H, and I J, parallel to A B; let C represent the centre, A C = the radius, and A B = the circumference or time of one revolution at its greatest diameter; therefore the lines E F, G H, and I J, will also represent their circumference, or time of one revolution, at their respective radii at E, G, and I; and as the lines A B, E F, G H, and I J, are one-half the length of each other, so will their revolutions be performed in similar proportions of time, and the velocity of the lathe-mandril will be increased in the inverse ratio, as the length of the lines A B, E F, G H, and I J; consequently the right-angled triangle A B C will represent the time that would be required to turn a surface, when the velocity of the lathe-mandril is increased as above described; and the parallelogram A B C D will represent the time that would be required, if the velocity of the lathe-mandril remains the same throughout, as when the tool was applied at its greatest diameter; for, if the length of the line A B represent the time of one revolution at its greatest diameter, the line C D will represent the time of one revolution when the tool has arrived at the centre; therefore, as the length of the line C D is equal to A B, so will all the intermediate revolutions be performed in similar spaces of time.

What length of time would be required to turn a surface of cast iron, the diameter being 24 inches, to make 50 revolutions or cuts in each inch of the radius, and to pass the tool at the rate of 15 feet per minute? × the circumference = 75·39 inches by the radius = 12 inches, then × the product = 904·68 by 50, the number of revolutions or cuts in one inch of the radius, which will be = 45334 inches, ÷ by 12, will reduce it to 3769·5 feet; ÷ again by 15, will bring it to 251·3 minutes; then ÷ by 60, will reduce it to 4 hours 11·3 minutes, consequently this would be the time, if each revolution be performed in equal portions of time; but if the velocity of the lathe-mandril on the surface to be turned be increased so as to pass the tool always at the same velocity, then the time will be only one-half of the above; for in this case we must multiply the radius only by one-half the circumference, as that will be a mean proportion of the lengths of all the intermediate revolutions.

To turn a surface of cast iron, the velocity of the part where the tool is applied should not exceed from 10 to 15 feet per minute; but this will depend on the hardness of the iron.

We shall now proceed to describe the method of reducing or increasing the velocity of the lathe-mandril, without stopping the lathe, the velocity of the first mover or axis, remaining the same throughout.

Plate X. fig. 1, is a geometrical elevation of the back part of the lathe; fig. 2 is an end elevation, viewed from the left-hand end of fig. 1, having the poppet-head removed; fig. 3 is a plan, or bird's-eye view, of the lathe. The same letters and figures refer to the same parts in all the views.

A and B are two cones fixed upon their axes C C and DD; the axes are placed parallel to each other, and are supported, and turn in plummer-blocks E E and F F; the plummer-blocks are fixed to the sides of two upright posts G and H, the posts being previously placed perpendicularly, and their ends secured to the floors above and below; the lower plummer-blocks F F have oblong holes, or slits, at each end, through which the bolts pass that secure them to the posts; the use of the slits is to admit of the plummer-blocks being slid up or down, so as to regulate the tightness of the band or strap I; below the plummer-blocks F F are fixed to the posts two plates or blocks J J, having a projecting boss at their upper ends, which contains an adjusting screw, for the better convenience of raising or lowering the plummer-blocks: there are also two small brackets K K fixed to the side of the posts; they are also shewn on a larger scale at figs. 5, 6, and 7. Fig. 5 is a similar view as shewn in fig. 1; fig. 2 is a plan, and fig. 3 an end view. The use of these brackets is to support the ends of the rods L L; the brackets must also have an adjustment for raising or lowering them, so as to have the rods in a line with the crossing of the strap I, as it passes from one end to the other of the cones A and B; the rods ought also to be fixed parallel to each other; the use of them is to support and guide a carriage M through holes, in the ends of which the rods pass; and it must be at liberty to slide freely from one end of the rods to the other. The carriage M contains three rollers, or cylinders, for reducing the friction or rubbing of the strap I at its crossing; the rollers are made of steel, and their ends reduced to a smaller diameter, and hardened; they are supported, and at liberty to turn freely in holes made in the sides of the carriage, which are also made of steel, and hardened; the middle roller, when at work, will run at a considerable velocity, but the other two might almost be dispensed with. N is a triangular bracket or frame, which is screwed to the under side of the upper floor. O O is a parallel axis, one end of which is supported and turns in a hole in the lower end of the bracket N; the other end of the axis is supported in a hole in the lower part of the flanch of the plummer-block E; and on that end of the axis are two short cylinders *a* and *b*.* The cylinder *a* is fixed on the axis O O; the cylinder *b* is at liberty to turn round, but may be fixed in any position by a screwed nut *c*, which is screwed on the axis O O, against the end of the cylinder *b*: there is also a projecting flanch at the outer ends of the cylinders, which is to prevent the catgut bands *d d* and *e e* from slipping off the ends of the cylinders; *f* and *g* are two conducting pullies, which are at liberty to turn freely on cylindrical pins fixed on the brackets K K; the pulley *f* has a single groove, and the pulley *g* a double one. Close to the side of the flanch, on the side of the cylinder *a*, is a screwed hole, in which one end of the catgut band *d d* is screwed or fixed; the band is then wound once round the cylinder *a*, and brought down parallel to the side of the post G, passing beneath the pulley *g*, and the crossing of the strap or band I, round the pulley *f*, and is screwed into, or fixed in a boss at *d*, on the end of the carriage M; the band *d d* must be long enough to admit the carriage to slide to that end of the rods L L, which is beneath the larger end of the upper cone A; the axis O O, together with the cylinder *a*, must then be turned round till the band *d d* has drawn the carriage M to the other end of the rods L L; there is also a screwed hole by the side of the flanch of the cylinder *b*, in which one end of the band *e e* is screwed; the band must then be passed once round the cylinder *b*, in a contrary direction to that of the band *d d*, brought down parallel to the post G, crossing the band *d d* round the other groove on the pulley *g*, and then screwed into a hole in a boss on the end of the carriage M at *e*. The band *e e* must also be long enough to admit the carriage beneath the smaller end of the upper cone A; the axis O O, together with the cylinder *a*, must be held fast, the cylinder *b* turned so as to tighten the bands sufficiently, and then secured in that position by the screwed nut *c*. Towards the other end of the axis O O is fixed a fusee or conical pulley P, with a spiral groove to receive a catgut band; the larger end of the fusee is nine inches in diameter, and the smaller end three inches, that is, from centre to centre of the band when in the groove. The length of the fusee is six inches, and there are two grooves cut in a circular direction round the fusee, about half an inch from each end, in which the ends of the spiral groove terminate; so that when the band has traversed from one end of the fusee to the other, the groove cut in a circular direction will prevent the band from slipping off the end. The spiral groove makes about twelve turns, therefore the diameter of the cylinders *a* and *b* must be in such proportion, that twelve turns of the bands *d d* or *e e* will draw the carriage M from one end to the other of the cones A and B. There is also another fusee Q, similar to the one above described, which is fixed on an axis *h*: but we shall describe the manner of supporting the axis *h*, &c. hereafter.

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* **See fig. 35, plate xii. which is a side view of the cylinders and part of the axis O O; and also fig. 36, which is a section of the cylinder. The above figures are drawn to a larger scale, so as to be better understood.**

We shall now proceed to describe the construction of the lathe-mandril and its appendages.

Plate XI. fig. 1, represents a longitudinal section, cut in a vertical direction, of the mandril-frame or head, centre-head 1 *b*, and slide-tool 1 *a*, together with part of the lathe-bed. Fig. 2 is a cross section of the lathe, mandril-frame, and bed. Fig. 4 is an end view of the centre head. The figures in Plate XI. are drawn to a larger scale than those in Plate X., consequently the smaller parts will be better understood by referring to Plate XI. R R is the lathe-bed, and is supported on iron brackets, or frames, S S; that part of the frame and bed which supports the mandril-head is separated from the other part of the bed, for the better convenience of chucking any thing of a large diameter; but the frames S S are firmly screwed together; they are represented with the bottom parts broken off in fig. 1, Plate X., for want of room: T T is the mandril-frame, or head, having two hardened steel collars, or bushes, *i* and *j*, driven tight into the cast-iron head; the holes in the collars are made a little conical, both in the same direction, for the better convenience of fitting and grinding in the mandril *k;* there is no shoulder on the mandril to prevent it from being pushed too tight into the collars, but the small or back end of the mandril acts against the face or flat end of an adjusting screw *l*, which prevents the mandril from fixing itself in the collars; consequently, the friction of the small end of the mandril, running against the face of the screw *l*, will be much less than when a shoulder on the thick end of the mandril runs against the face of the collar; see fig. 3, Plate XI., which is the smaller end of the mandril, &c. drawn on a larger scale; the adjusting screw *l* is prevented from turning, by a set screw *m* pushing a cylindrical piece of brass against the screw *l*. Those parts of the mandril which run in the collars *i* and *j*, and also the small end and the adjusting screw, are all made of hardened steel; there is also a steel collar *n* very nicely fitted and fixed on a cylindrical part of the mandril, and the face of which runs against the face of the collar *j*, and of course prevents any shake or motion of the mandril end-ways; there is a small set screw in the side of the collar *n*, the end of which goes into a short groove in the side of the mandril, and prevents the collar from turning on the mandril; there is also a nut *o* screwed on the end of the mandril, against the end of the collar *n*, for adjusting and securing the collar in its proper place; the face of the collar *n* is also made hard. U is a short hollow cylinder or reservoir, with a flanch fitted into the back part of the frame T T, and fixed by four screws; there is also a circular groove cut in the frame beneath the flanch, in which is placed a small ring of leather, to prevent any oil making its escape between the flanch and the frame; a long hole or opening is made on the upper side of the reservoir, to admit a screw-driver or pin for the adjustment of the collar *n* and nut *o*, (without taking off the reservoir,) and also for pouring in oil. V is a thin hollow cylinder or cover, which is slid upon the reservoir, to exclude dust, &c. from getting amongst the oil; the reservoir and cover are made of gun-metal; the back end of the reservoir also contains the adjusting screw *l* and set screw *m*, altogether making a neat finish to the back part of the mandril-frame; a small notch is made in the lower side of the end or face of the collar *j*, against which the collar *n* runs, and communicates with a small longitudinal groove which extends nearly to the other end of the collar; consequently, if the reservoir U be nearly filled with oil, it will be readily conveyed to all the moving or rubbing parts of that end of the mandril. It is found that no oil makes its escape between the collar and the mandril, unless the mandril be in motion, and then only a very few drops in the course of a day. The other end of the mandril is supplied with oil in the usual way; the middle part of the mandril is a little conical, having a longitudinal groove to receive a key. W is a spur-wheel, (made of gun-metal,) the face of which is a dividing plate; X and Y are two flat pulleys or drums fitted on the socket and screwed to the arms of the wheel; the hole in the socket of the wheel is well fitted, and ground upon the mandril; there is also a longitudinal groove in the hole of the socket, opposite that of the mandril, to which is fitted a key or feather, to prevent the wheel from turning on the mandril; the feather is fixed in the groove in the socket, otherwise the mandril would not pass through the collar *i*; there is also a small pulley, with a groove to receive a cat-gut band, and an endless screw Z fitted and secured from turning on the mandril, in a similar manner as the wheel W; *p* is a small spur-wheel or pinion, which is screwed on the mandril, and acts against the end of the socket of the endless screw, by which means the wheel W, &c. is prevented from moving end-ways on the mandril, and, of course, will form one solid mass, and greatly tend to stiffen the mandril.

A mandril that is constructed on the above plan will admit of a shoulder and screw of a much larger diameter for receiving the chucks, &c., as, from the smallness of these screws in common lathes, they are frequently twisted off. The wheels or pulleys on lathe-mandrils ought to be fixed as near to the collar *i* as they will admit of; for, the nearer the wheel, &c. is to the chuck, the less will be the twist or spring of the mandril; but in large turning lathes it is best to have the wheels that give motion to the mandril fixed to the back or periphery of the chuck, then all the strain or twist will be removed from the mandril: *q* is an axis which is supported and turns in plummer blocks *r r*, fixed on brackets or projecting parts of the mandril-frame; *s* is a spur-pinion, which is fixed on the axis *q;* the pinion gives motion to the wheel W on the mandril, and is one-fifth of its diameter; but when a slow motion of the mandril is not wanted, the pinion may be slid along its axis, out of gear with the wheel; *t* is a drum which is fixed with two set screws to the outer end of the axis *q*, therefore the drum *t* may be easily changed for one of a greater or less diameter, as required; the longer end of the axis C of the upper cone is supported by a bracket fixed to the upper floor; there are also four drums fixed on the axis C by set screws, each having two screwed through the boss or nave against the axis C; consequently, any of the drums on the axis C may be easily moved opposite those on the mandril on the axis *q*. The drums on the axis C are 12, 18, 26, and 36 inches diameter, and a similar set belongs to the axis *q;* therefore the motion of the drums on the axis C may be communicated directly to the mandril or through the axis *q*.

We shall proceed to calculate the quickest and slowest speed that may be communicated to the lathe-mandril. Suppose the axis of the lower cone B to make 30 revolutions per minute, move the strap I to the larger end of the cone B, place the drum of 36 inches diameter (on the axis C) opposite the smallest drum Y, which is 8 inches diameter, on the lathe-mandril, and place the strap *u* on the said drums; multiply the diameter of the larger end of the cone B = 36 inches, by that of the drum on the axis C = 36 inches; then multiply the diameter of the smaller end of the cone A = 12 inches by the drum Y on the mandril = 8 inches; then divide the product of the two first numbers = 1296 by the product of the two second = 96. 1296 ÷ 96 = 13·5 revolutions of the mandril for one turn of the winch, which × by 30 revolutions of the winch per minute, will make the velocity of the mandril = 405 revolutions per minute; but if the strap I be moved to the smaller end of the cone B, the velocity of the mandril will only be 45 revolutions per minute, or one-ninth of 405; for, as the larger ends of the cones are three times the diameter of the smaller, the velocity of the upper cone A will be increased or diminished in the ratio, as the square of the diameters the larger ends of the cones divided by the square of the diameters of the smaller ends.

$$\text{Thus, } \left\{\begin{array}{l} 36 \times 36 = 1296 \\ 12 \times 12 = 144 \end{array}\right\} 1296 \div 144 = 9.$$

It is therefore evident that all the intermediate velocities of the mandril, from 405 to 45, may be obtained without stopping the lathe, by moving the strap I from the smaller end of the upper cone A to that of the larger. By comparing the greatest velocity of the lathe-mandril, = 405 revolutions per minute, with that of the slowest, = ·66 of a revolution, (see the following Table,) they will stand thus:

As ·66 : 405 :: 1 : 615·15;

consequently, one revolution of the lathe-mandril, when at its slowest speed, will require the winch on the axis of the lower cone B to be turned 45 times round, and at the rate of 30 revolutions per minute, which will be equal to 1·5 minute, and which is slow enough to turn a surface of cast iron 6 feet diameter, passing the tool at the velocity of 12 feet per minute.

The following Table shews the different velocities or number of revolutions per minute that may be given to the lathe-mandril, (by fixing the drums on the axis C, in succession opposite those on the mandril and axis *q*,) supposing the winch on the axis D to make 30 revolutions per minute.

The number of Turns per Minute of the Cone B.	Diameters of the Cone B in Inches.	The Number of Turns per Minute of the Cone A, and Drums.	Diameters of the Cone A.	Diameters of the Drums to be used on the Axis of the Cone A.	Diameters of the Drums on the Mandril.	Diameters of the Drums on the Axis *q*.	Number of Teeth in Pinion on the Axis *q*.	Number of Teeth on the Wheel W on the Mandril.	Number of Turns per Minute of the Mandril, when the Strap I is at the larger end of the Cone A.	Number of Turns per Minute, when the Strap I is at the smaller end of the Cone A.
30	12	10	36	36	8	—	—	—	45	405
—	—	—	—	26	—	—	—	—	32·5	382·5
—	—	—	—	18	—	—	—	—	22·5	202·5
—	—	—	—	12	—	—	—	—	15	135
—	—	—	—	36	16	—	—	—	22·5	202·5
—	—	—	—	26	—	—	—	—	14·62	131·58
—	—	—	—	18	—	—	—	—	11·25	101·25
—	—	—	—	12	—	—	—	—	7·5	67·5
—	—	—	—	36	—	12	16	80	6	54
—	—	—	—	26	—	—	—	—	4·33	38·97
—	—	—	—	18	—	—	—	—	3	27
—	—	—	—	12	—	—	—	—	2	18
—	—	—	—	36	—	36	—	—	2	18
—	—	—	—	26	—	—	—	—	1·44	12·96
—	—	—	—	18	—	—	—	—	1	9
—	—	—	—	12	—	—	—	—	·66	5·94

We shall now proceed to describe the construction of the slide tool and its appendages. There are four general views of it in Plate X., which shews its connexion with the lathe and the carriage M, &c.; but as they are drawn to so small a scale, it will be better to refer to Plates XI. and XII., where they are shewn on a larger scale.

Fig. 1 *a*, Plate XI., is a section of the slide tool cut by a plane parallel to the bed of the lathe.

Fig. 1, Plate XII., is a view of the face of the chuck *v*, the slide tool and the apparatus for communicating motion to it, together with a section of the bed of the lathe. Fig. 2 is a plan of the slide tool, &c. projected from fig. 1. The rest of the figures up to 30 are a detail of the various parts of the slide-tool; and the remaining figures a detail of the apparatus for giving motion to the carriage M, as before described. Fig. 3, Plate XII., is a view of the under side of the base plate of the slide-tool. Fig. 4 an end view, and fig. 5 an edge view, together with a section of the lathe-bed R R, &c. 1 is a parallel plate, to the under side of which are screwed two parallel pieces 2 2, and parallel to each other; the inner edges of the two pieces 2 2 are bevelled, and form an angle of 45° with the base plate 1. Fig. 6 is a view of the under side of an apparatus for guiding and also fixing the base plate 1 on the lathe-bed; and fig. 7, an end view, which is constructed of the following pieces: 3 is a parallel plate or slide, having its edges bevelled to the same angle as the pieces 2 2, and is nicely fitted into, and at liberty to slide in, the dove-tailed groove formed on the under side of the base plate 1, and between the pieces 2 2. 4 is a piece which is firmly screwed to the under side of the dove-tailed slide 3, and is also nicely fitted between the sides of the lathe-bed, so as to slide easily, but without any shake: in the middle part of the piece 4 is a screwed hole to receive a screw 5. 6 is a plate or washer, which extends across the under part of the lathe-bed; it has also a hole in the middle to receive the neck, but not the head of the screw 5. There are two pieces 7 7, which are also screwed to the under side of the dove-tailed slide 3, and at right angles to it. The pieces 7 7 are adjusted to the outer edges of the lathe-bed, which prevents it from springing outwards; the dove-tailed slide 3 is made a little thinner than the pieces 2 2, consequently, when it is placed across the lathe-bed, and the base plate 1 is slid upon it, the pieces 2 2 of the base plate will rest on the lathe-bed, but the dove-tailed slide 3 will not touch it; therefore, when the screw 5 is screwed into the piece 4, it will fix the base plate at right angles to the lathe-bed; but when the screw is slackened, the base plate may be slid across the lathe-bed as required, or it may, together with the dove-tailed slide 3, be slid along the lathe-bed and fixed to it in any situation. 8 is a short cylinder with a flanch at each end (see fig. 8, which is a side view); the lower flanch is fixed at the end and on the upper side of the base plate by four screws. 9 is the bed of the slide-tool (see fig. 11, which is a side view, fig. 12 a cross section, and fig. 13 a view of the upper side of it); the under and upper sides of the bed 9 are level and parallel to each other; near to one end, and on the lower side of the bed 9, is formed a circular flanch or plate, equal in diameter to the upper flanch of the cylinder 8; each of them has a hole in the centre, in which is a screwed bolt; the head of the bolt is sunk level with the upper side of the plate of the bed, and the screwed nut is sunk level with the under side of the flanch or top of the cylinder. That part of the bolt which passes through the lower flanch is fitted into a six-sided hole, which is to prevent the bolt from turning round, otherwise the screwed nut would be undone when the slide-tool bed 9 is turned in one direction, and perhaps be too tight when turned in the other; but when well fitted, the slide-tool bed may be turned in any position, and fixed by two screws 10 10 (see fig. 1, *a*, Plate XI.) In each side of the flanch of the slide-tool bed, and concentric with the centre screw, is a circular groove, through which the screws 10 10 pass, and screw into holes made in the upper flanch of the cylinder 8; these circular grooves will admit of the slide-tool bed to be turned a quarter round, without taking out the screws 10 10. There are eight screwed holes in the upper flanch of the cylinder 8 (concentric with the centre screws) for receiving the screws 10 10, therefore the slide-tool bed may be fixed in any required position. The outer edges of the upper side of the slide-tool bed are bevelled so as to form a dove-tail, and they are also made parallel to each other; there is an opening between the sides to admit of a screw 11, and its screwed nut 2; the necks of the screw 11 are supported, and turn in holes made in the end of the slide-tool bed 9; the caps that form the upper half of the holes are secured with two screws, and must be removed when the screw 11 is put in or taken out, for the necks of the screw are only the diameter of the bottom of the thread. On the right hand end of the screw 11 is fitted a cylindrical collar 13 (see fig. 26), which is a section of that end of the screw and collar, and fig. 28 a side view; they are drawn to a scale of double the size of fig. 2, so as to be better understood); there is a hole between the collar and the screw, in which is fitted a pin or key, to prevent the collar turning on the screw; the shoulder of the collar is hardened and works against the end of the bed. 14 is an adjusting screw, which is screwed into the end of the long screw 11, and the head acts against the end of the collar 13, so that the distance between the shoulder of the collar and the shoulder at the other end of the long screw 11 may be adjusted at any time, so as to have no motion endways. 15 is a winch or handle, which is fitted on the collar 13, and is prevented from turning on the collar by a feather which is fixed in a groove on the side of it; the feather also fits in a groove in the inside of the socket of the handle; the adjusting screw 14 also acts against the end of the socket of the handle, and prevents it from coming off; or the handle may be placed on the other end of the long screw, if it be more convenient, the end of which is shewn at fig. 27. All the parts of the slide tool hitherto described are made of cast iron, except the screws, which are made of cast steel. Fig. 15 is a view of the upper side of the carriage of the slide tool, fig. 16 an edge view, fig. 17 a view of the under side, and fig. 18 an end view, which is constructed as follows: 16 is a parallel plate, to the under side of which are screwed two parallel pieces 17 17; the inner edges of those pieces are bevelled, and form an angle of 45° with the plate 16; they are also parallel to each other, and adjusted so as to fit the dove-tail on the upper side of the slide-tool bed 9; in the middle, between the pieces 17 17, and on the other side of the plate 16, the nut 12, in which the long screw works, is fixed by two screws, the heads of which are on the upper side of the plate 16 (see fig. 15); therefore the nut 12 may be disengaged from the plate or carriage without taking the long screw out, and the carriage slid off the end of the bed 9 and reversed; for, in some cases, the slide-tool bed is required to be turned one-half round. The holes that receive the two screws for fixing the nut 12 to the plate 16 are arranged so as to be opposite each other, whichever way the carriage is placed; the nut is constructed of two pieces, and screwed together by two screws (see fig. 30, which is an end view of the nut 12, fig. 29 a side view, and fig. 28 a view of the upper side), therefore the nut may be adjusted so as to have no loss of time or motion endways on the long screw. On the upper side of the plate or carriage 16 are fixed two dove-tailed slides 18 18; see fig. 16, which is a view of the edge of the plate, and ends of the slides. Fig. 15 is a view of the upper side of the carriage, having one of the slides 18 removed, the under side of which is shewn in fig. 19; *w* is the upper carriage or slider for holding and fixing the tools; fig. 20 is a view of the under side of the carriage *w;* fig. 21 a side view; fig. 22 a view of the left hand end of figs. 20 and 21; and fig. 23 a view of the opposite end.

On the under side of the carriage *w* are screwed two parallel pieces 19 19, the inner edges of which are bevelled to the same angle, and of the same thickness as the dove-tailed slide 18; the carriage *w* is slid upon the slide 18, and adjusted by the set screws in the side of the carriage, so as to be slid backward and forward without any shake or motion sideways; *x* is a screw for moving the carriage *w* to and fro, and also holding it in any required position; the neck and shoulder of the screw *x* is fitted into a hole in the end of the carriage *w*; there is also a collar sunk in the outer end, see figs. 24 and 25, which are views of its edge and face; the collar acts against the other shoulder of the screw *x*, and is fixed by three screws to the carriage; therefore the collar may be adjusted in case of its wearing, so as to prevent any lateral motion of the shoulder of the screw; there is a long hole between the carriage-plate 16 and the slide 18 for receiving the screw *x*; one end of the hole is screwed, but the other is made wider, so as to clear the screw, see figs. 15 and 19, where one-half of the hole is shewn in each; but one-half of the screwed end of the hole consists of a screwed nut, which is well fitted in a notch formed in the edge of the plate 16 and the end of the slide 18, and secured by two small screws, so that as the screw and nut wear, the loss of time or lateral motion of the screw may be adjusted; on the end of the screw is fitted a winch or handle 20, in a similar manner as the handle 15 before described; there is also a micrometer wheel 21, (fixed on the end of the screw, between the socket of the handle and the end of the carriage *w*,) which is divided into 100 parts; one inch of the screw contains 10 threads or turns, consequently if the micrometer be turned one division, the screw will move the carriage, together with the tool 22 (see fig. 2), the 1000th part of an inch; the collar 13 of the long screw is also divided into 100 parts, and the screw contains 9 turns in an inch. The micrometer 21 is of the greatest importance, not only for adjusting the depth of the cut of the tool, but for ascertaining the parallelism of the slide-tool-bed 9 with the axis of a cylinder intended to be turned, or that of the face of the chuck *v*, when the slide tool is set to turn a surface; the edge of the upper flanch of the cylinder 8 is divided into 360, and a nonius or vernier on the edge of the flanch of the slide-tool-bed to correspond with it, so that the slide tool may be adjusted very near to the angle required. To adjust the slide tool to turn a cylinder, slacken the screws 10 10, turn the vernier of the slide tool to zero, the bed will then be at right angles to the base-plate 1, and parallel to the lathe bed, as shewn in fig. 4, Plate X.; but as the radius of the flanch of the cylinder 8 is only 4 inches, it becomes difficult to adjust the slide tool to turn a cylinder two feet long by that adjustment; but the error may be easily corrected: tighten the screws 10 10, turn a little piece opposite the centre screw of the slide-tool-bed (of the cylinder intended to be turned), examine the micrometer 21 on the screw *x*, and mark down the number; turn back the handle of the screw *x*, say five turns, so that the point of the tool will clear any part of the cylinder, screw the carriage 16 to the other end of the slide-tool-bed, by turning the handle 15 of the long screw, then turn a piece at that end of the cylinder of the same diameter as the first, examine the number on the micrometer 21 before the tool is drawn back, and if the number be the same as noted down, the slide tool will be parallel to the axis of the cylinder; if not, slacken the screws 10 10 a little, adjust the micrometer to the number before noted down, turn the slide-tool-bed till the point of the tool 22 just touches that part of the cylinder last turned, then tighten the screws 10 10, and the slide-tool-bed will be parallel to the axis of the cylinder intended to be turned, or to the centres of the lathe. As the slide 18 (on the carriage 16) is fixed at right angles to the slide-tool-bed, consequently the motion of the upper carriage *w* will be also at right angles to that of the lower carriage 16; therefore, when the bed of the slide tool is adjusted to turn a cylinder, by turning the handle of the upper screw *x*, the motion of the carriage *w*, together with the tool, will turn a surface; but if the radius of the surface be greater than the motion of the carriage *w*, it will be best to turn round the slide-tool-bed 90°, as shewn in figs. 1 and 2, Plate XII., and figs. 1, 2, and 3, Plate X., then the bed of the slide tool will be parallel to the face of the chuck *v*, and at right angles to the lathe bed. The best way of ascertaining the parallelism of the slide-tool-bed with the face of the chuck *v*, is to fix a tool in the carriage *w*, then turn the handle 15 of the long screw till the point of the tool is opposite the centre screw of the slide-tool-bed, screw forward the tool till it just touches the face of the chuck, mark that part of the chuck with chalk, examine the number of the micrometer and mark it down, then draw back the tool a little to clear the face of the chuck, turn the chuck half round, screw forward the tool by turning the handle 15 till the tool has arrived at the chalked part of the chuck, then screw forward the tool with the handle 20 till the point of the tool just touches the chalked part of the chuck, examine the number of the micrometer, and if it be the same as before marked down, the slide tool will be parallel with the face of the chuck; but if the number of the micrometer be not the same, slacken the screws 10 10, adjust the micrometer to the number first marked down, turn the slide-tool-bed till the point of the tool just touches the chalked part of the chuck, tighten the screws 10 10, and the slide tool will be parallel to the face of the chuck; but it would be advisable to repeat the same operation over again. When the slide-tool-bed is placed as above described, the right-hand end of it rests on a bridge 23, (see figs. 9 and 10, Plate XII., which is an end and side view, and a view of the upper side of it is shewn in fig. 2); this bridge is fixed to the base-plate 1 of the slide tool by two screws; the right-hand end of the slide-tool-bed has a projecting piece in which is a groove concentric with the centre screw of the bed of the slide tool, and through which passes a screw for fixing it to the upper part of the bridge 23; the bridge tends greatly to strengthen and stop the vibration of the slide tool.

Having described the construction of the several parts of the slide tool, we shall now proceed to point out some of its advantages over those that are commonly made. First, the cylinder 8 and the bridge 23 are only for raising the slide tool to a proper height with the centre of the lathe mandril, which is ten inches above the lathe bed; consequently, if they are removed, the bed of the slide tool may be fixed in a similar manner to the upper side of the base-plate 1, then the tool will be only six inches above the lathe bed, and, of course, may be applied to a six-inch lathe; or the slide tool may easily be applied to a lathe of any greater height, by making the cylinder 8 and bridge 23 to correspond. Secondly, the use of the two slides 18 18 is, that the carriage *w* (of the tool) may be removed from one to the other, by which means a greater diameter of surface or length of cylinder may be turned without moving the bed of the slide tool. Thirdly, the circular motion of the slide tool being below the two right-line motions, and always at right angles to each other, consequently the longer screw or motion of the carriage of the slide tool may be applied to turn either a cylinder or a surface, without the two screws for moving the carriages being both brought in the same direction; and it also admits the motion or sliding part of the lower carriage to be higher up, which will, of course, tend to make the tool much steadier. There is also an advantage in the construction of the upper carriage *w*, in which the tool is fixed; first, as the slide 18 is screwed to the plate of the lower carriage 16, and the side pieces 19 19 to the upper carriage *w*, consequently the base of the upper carriage *w* is broader than those made in the ordinary way, that is, when the side pieces are fixed to the lower carriage, and the carriage which holds the tool slides between them; in this case the tool must project, out of the carriage in which it is fixed, over the side piece without being supported, and also as much more as the tool is intended to be screwed forward towards the axis of the thing that is to be turned; for the tool and the upper carriage, together with the frame that supports them, are screwed forward altogether, therefore the frame would come in contact with the most prominent part of the thing to be turned, did not the tool project sufficiently out, therefore the tool will be subject to much vibration.

In this improved slide tool, the tool may be fixed in the upper carriage close to either side, and also over one of the side pieces 19, which will of course make a solid support for it; when the tool is bent a little to one side, so as to project past the side of the carriage, then the side of the carriage will clear the face of the thing to be turned; the upper carriage, together with the tool, may be screwed about four inches over the inner side of the lower carriage; therefore, in most cases, the tool need only project a little before that part of the carriage where it is fixed, which will of course support and tend greatly to stop the vibration of the tool; the tool may be fixed across the upper carriage when required, and when in that situation it will be also supported at the very edge of the carriage, for the side pieces 19 19 rest upon the plate of the lower carriage; the tool may also be fixed in either direction in the square hole in the middle of the carriage by the set screw, as shewn in fig. 2: the several parts of the two carriages are made of gun metal, except the side pieces 19 19, which are of cast iron; therefore, whenever a sliding motion takes place, one part of the metal is of cast iron, and the other of gun metal: the screws are all made of cast steel.

We shall now proceed to describe the manner of communicating the motion of the lathe mandril to the screw of the slide tool: 24 is an arm or bracket (see fig. 3, Plate X. and fig. 2, Plate XI.), which is fixed to the upper side of the frame of the lathe mandril, and projects on each side of it; to one end and on the under side of the arm 24 is screwed a bar or lengthening-piece 25, which is to extend the arm 24, when the radius of the thing to be turned exceeds the distance between the centre of the mandril and the axis 26; 27 is a pillar, the lower end of which passes through a round hole in the end of the piece 25, and is secured by a screwed nut sunk in the under side of it; on the upper end of the pillar 27 are two narrow plummer blocks 28 28 (see fig. 7, Plate XI.); 29 is a hollow cylinder or socket, the ends of which are made a little smaller, and fitted into the holes, and at liberty to turn in the plummer blocks 28 28; on one side of the socket 29 is a projecting piece, in which is made a round hole to receive the end of an axis 30; the other end of the axis is supported, and turns in a hole in the upper end of a sliding piece 31 (see fig. 8, which is a side view of it); in the sliding piece 31 is a long groove, through which pass two screws 32 32, that fix it to the other end of the arm 25; the end of the arm forms a segment of a circle, the centre of which is the centre of the socket 29 and axis 26; 33, 34, 35, and 36, are four endless screw wheels, made all of one piece, the socket of which is well fitted to the cylindrical axis 30, but may be slid to and fro, so as to bring any of the wheels perpendicular to the axis of the lathe mandril, and fixed upon the axis 30 by a set screw in the right-hand end of the socket (see fig. 2). Therefore, if the screws 32 32 are slackened, the piece 31, together with the axis 30 and its appendages, may be slid up or down, so as to put into geer any of the endless screw wheels with the screw Z which is upon the lathe mandril, and may again be fixed in its required position by the screws 32 32: it will also be observed, that when the end of the axis 30, &c. is slid up or down, that the socket 29, which supports the other end of the axis 30, will turn in the plummer blocks 28 28, consequently the centre of the axis 30 will always be in a direct line with that of the axis 26: one end of the axis 26 is also supported and turns in the socket 29; therefore the bevel wheel 37, which is fixed on the axis 26, and the bevel pinion 38, which is fixed on the axis 30 (by set screws), will always be properly in geer with each other. 39 is a collar which is fixed upon the axis 30 by a set screw; the shoulder of the collar acts against the face of the piece 31, and, of course, prevents any lateral motion of the axis 30; the number of teeth in the bevel wheel 37 is three times that of the pinion 38; as the diameters of the axis 26 and 30 are the same, therefore the situation of the bevel wheel 37 and the pinion 38 may be changed when the speed of the axis 26 is required slower, the axis 30 will then make nine revolutions for one of the axis 26: there is also a pair of bevel wheels of equal numbers of teeth, which may be applied in the place of those before described (see fig. 3, Plate X.); 39 is a bracket or projecting piece, made of cast iron, which is fixed by screws to the upper side of the base-plate 1 of the slide tool (see fig. 31, which is a view of the upper side of it, detached from the slide tool); 40, 41, 42, 43, 44, and 45, are short pillars, made of gun metal, the lower ends of which pass through round holes, marked with corresponding figures, made in the bracket 39, and are fixed by screwed nuts sunk in the under side of it; 46 is a cylindrical axis which passes through, and is at liberty to turn in holes made in the upper ends of the pillars 40 and 41; there is a shoulder formed on the axis 46, which acts against the inner side of the pillar 40, and on the right-hand end of the axis 46 is formed a pivot, the shoulder of which acts against the inner side of the pillar 41; these shoulders are to prevent any lateral motion of the axis; the centres of the axis 46, and the long screw 11 of the slide tool, are in a direct line, when the slide tool is set to turn a surface; they are also connected together by a coupling box 47, one part of which is fixed in the end of the screw in the place of the handle; the other part of the box is fitted upon the end of the axis 46, and is prevented from turning round upon it by a feather fixed in the side of the axis; that part of the coupling box may be slid to and fro upon the axis 46, so as to put it in or out of geer with the other part of the coupling box by the action of a lever 48; the lever is supported and turns on a stud formed on the upper end of the pillar 43; on the upper end of the pillar 42 is formed a plummer block, in which is supported the other end of the axis 26; the axes 26 and 46 are level, and also at right angles to each other; on the end of the axis 26 is fitted a bevel wheel 49; 50 and 51 are two bevel wheels, which face each other, and are made of one piece; they are fitted upon the axis

46, and are prevented from turning round on it by a feather fixed in the side of the axis; they may also be slid backward or forward, so as to put either of them in geer with the bevel wheel 49; therefore the direction of the motion of the axis 46 may be changed by turning to and fro the handle of a lever 76; the other end of the lever 76 acts between two shoulders formed on the middle part of the socket of the bevel wheels 50 and 51, and is also supported and turns on a stud formed on the upper part of the pillar; the bevel wheels 50 and 51 are at such a distance from each other as to clear the bevel wheel 49 about the eighth part of an inch, that is, when the handle of the lever 76 is placed in the intermediate position, by which means the motion of the axis 46 may be stopped when required, although the axis 26 remains in motion. Having described the method of communicating the circular motion of the lathe mandril to the long screw of the slide tool, we shall now point out the number of revolutions that the mandril will make for one of the long screw of the slide tool, supposing the wheels to be placed as shewn in fig. 2, Plate XI. The endless screw wheel 36 has 37 teeth, the endless screw on the mandril makes one revolution for each tooth of the wheel, the bevel pinion 38 makes three revolutions for one of the bevel wheel 37; 37 × 3 = 111 turns of the mandril for one of the long screw; therefore, as the long screw of the slide tool requires nine turns to move the tool one inch, the number of the cuts the tool will make in one inch will be 999, which is the highest number.

The following Table shews the number of turns the mandril will make for one of the long screw of the slide tool; and also the number of cuts made by the tool in one inch of the radius of the surface to be turned, by changing the situation of the endless screw wheels 33, 34, 35, and 36, the bevel wheel 37, the bevel pinion 38, and the mitre-wheels.

Mitre Wheel, Bevel Wheel 37, or Bevel Pinion 38, fixed on the Axis 30.	Mitre Wheel, Bevel Wheel 37, or Bevel Pinion 38, fixed on the Axis 26.	Number of Teeth in Endless Screw Wheel.	Number of Turns of the Mandril for one of the long Screw of the Slide Tool.	Number of Turns of the Mandril, or Cuts of the Tool in one inch of the Radius of the Surface to be turned, for nine Turns of the long Screw of the Slide Tool.
Pinion 38	Wheel 37	37	111	999
Ditto	Ditto	28	84	756
Ditto	Ditto	21	63	567
Ditto	Ditto	16	48	432
Mitre Wheel	Mitre Wheel	37	37	333
Ditto	Ditto	28	28	252
Ditto	Ditto	21	21	189
Ditto	Ditto	16	16	144
Wheel 37	Pinion 38	37	$12\frac{1}{3}$	111
Ditto	Ditto	28	$9\frac{1}{3}$	84
Ditto	Ditto	21	7	63
Ditto	Ditto	16	$5\frac{1}{3}$	48

We shall now proceed to describe the method of moving the strap I from one end to the other of the cones A and B, by the motion of the lathe mandril, or by turning the long screw of the slide tool by hand. On the upper ends and outer sides of the pillars 40 and 41 are projecting sockets concentric with the axis 46, on which turns a swing frame *y y* and *z z;* the frame consists of two side pieces, firmly secured at a proper distance from each other by two collar-bolts or cross-bars *z z;* in the lower ends of the side pieces *y y* are made round holes, which receive and are at liberty to turn on the sockets of the pillars 40 and 41; there are also round holes in the upper ends of the swing frame *y y,* in which are supported, and at liberty to turn, the pivots on the ends of the fusee axis *h;* there is a sliding frame or forked rod that keeps the upper end of the swing frame and axis *h* at a proper distance from the axis O O; the sliding frame consists of two pieces 52 and 53; one end of each piece is made to receive the fusees P and Q before described, see figs. 1 and 3, Plate X.; there are round holes made in the ends of the forks, through which passes, and is at liberty to turn, the axis O O in the fork 53, and the axis *h* in the fork 52; the shank of the fork 52 consists of a hollow cylinder, through which passes, and is at liberty to slide to and fro, the shank of the fork 53; it is prevented from sliding out of the cylinder by a pin which passes through a hole made in the cylinder, and also through a hole, about four inches long, made in the end of the shank 53; therefore, the sliding motion of the shank in the cylinder will be limited to four inches: on the middle part of the shank 53 is fitted a collar, which is fixed by a set screw; there is also a spiral spring placed on the shank, one end of which pushes against the shoulder of the collar, and the other against the end of the cylinder 52; the spring tends to extend the length of the sliding frame. In fig. 3, Plate X. part of the shank of the fork 53 is represented broken off, to shew the axis 26, &c. below it, and the end 52 of the fork, fusee, &c. are removed back for the same purpose to fig. 8, but they are shewn in their places in fig. 1; the use of the expanding frame is to keep a proper tension on the cat-gut band 54; the band is wound twice round each fusee P and Q, and its ends coupled together, by which means motion is communicated from Q to the fusee P; on each of the cross bars of the swing frame *y y* is a boss, through which passes, and is at liberty to turn, an axis 55; there are two shoulders on the axis, which act against the inner sides of the bosses on the bars *z z*, and prevent any lateral motion; on the fusee axis *h* is fixed a face wheel, or a wheel toothed on the face, (see figs. 33 and 34, Plate XII. and figs. 1 and 2, Plate X.) Fig. 33 is a side view of the upper part of the swing frame, and fig. 1 the lower part, the middle being removed to make it come within the limit of the plate; the upper part of the swing frame, fusee, axis, &c. are removed in fig. 2, so as to shew the parts below. Fig. 34 is a view of the face wheel 57 and pinion 56; there are six more concentric rings or toothed wheels, of different diameters, screwed to the face of the arms of the wheel 57, and which contain the following numbers of teeth, 30, 45, 60, 75, 90, 105, and 120; on the upper end of the axis 55 is fitted a spur pinion 56, of 15 teeth, which may be slid up or down the axis, and put in geer with any of the face wheels 57, and also fixed on its axis by a set screw; on the lower end of the axis 55 is fixed a bevel wheel 58, in which works a bevel pinion 59; the wheel is twice the diameter of the pinion; it is fitted on the axis 46, and has a long socket; the end of it is notched, (similar to that of the coupling box 47,) so as to receive the ends of a flat pin that is fixed in the axis; 60 is a lever, which turns on a stud formed on the upper end of the pillar 44; one end of the lever is fitted between two shoulders formed on the socket of the bevel pinion, and by turning the handle of the lever towards the left hand, the notches in the end of the socket will be withdrawn from the pin, and the axis will then be at liberty to turn within the socket of the bevel pinion; but if the handle of the lever be turned in the contrary direction, the notches in the end of the socket of the pinion will be slid upon the pin, and the bevel pinion will be properly in geer with the bevel wheel; therefore, if the axis 46 be turned round, (either by a motion from the lathe mandril, or by turning the handle of the long screw of the slide tool,) the bevel pinion 59 will turn the bevel wheel 58, and its axis; the pinion 56, on the upper end of the axis, will turn the face wheel 57, together with its axis *h*, and fusee Q; the fusee Q, together with its cat-gut band, will turn the fusee P and its axis O O; and the cylinders *a* and *b*, on the other end of the axis O O, together with their cat-gut bands *d d* and *e e* will draw the carriage M, together with the strap I, from one end of the cones A and B to the other; that is, if the long screw of the slide tool be turned in the direction so as to cause the tool to move from the outer side of the chuck *v* towards the centre of it; and the cones A and B must also be put in motion by turning the handle or winch D, or otherwise; then the carriage M, together with the strap I, will be drawn from the smaller end of the cone B to the larger. But if the long screw of the slide tool be turned in the contrary direction, the tool will move from the centre of the chuck towards the outer side of it, and the carriage M, together with the strap I, will be drawn from the larger end of the cone B to that of the smaller. The use of the seven wheels that are fixed on the arms of the face wheel 57 is for regulating the number of turns that is required of the long screw of the slide tool to move the carriage M, &c. from one end of the cones A and B to the other, and which must be regulated according to the diameters of the surfaces that are to be turned.

The following Table shews which of the face wheels 57 the pinion 56 must be put in geer with, to turn surfaces of various diameters. Opposite the diameter of the surface to be turned is the number of teeth in the face wheel, in which the pinion must be placed.

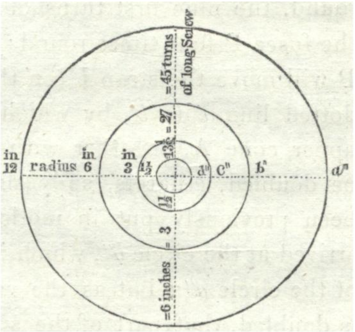
No. of Teeth in Face Wheel 57.	Diameter of the Surface to be turned.
30	12 inches and under.
45	12 ditto to 18
60	18 ditto to 24
75	24 ditto to 30
90	30 ditto to 36
105	36 ditto to 42
120	42 ditto to 48

This regulation will be best understood by first comparing the accelerated or retarded motion of the upper cone A, &c. with the uniform motion of the cone B, together with the progression of the carriage M and strap I. Let the length of the cones A and B be divided into three equal parts, as represented by the dotted lines at *a′*, *b′*, *c′*, and *d′*, then the diameter of the cones at each of these places, and also the number of turns that the cone A will make, while the cone B makes 2,828 revolutions, will stand thus:

$$\begin{array}{lclcl} & & \text{Diam. } \ \text{Turns.} & & \text{Diam. } \ \text{Turns.} \\ \frac{\text{Cone A}}{\text{Cone B}} & a' & \frac{35{,}35\ =\ 1}{12{,}5\ =\ 2{,}828} & b' & \frac{27{,}73\ =\ 2{,}05}{20{,}12\ =\ 2{,}828} \end{array}$$

$$\begin{array}{lclcl} & & \text{Diam. } \ \text{Turns.} & & \text{Diam. } \ \text{Turns.} \\ & c' & \frac{20{,}12\ =\ 3{,}9}{27{,}73\ =\ 2{,}828} & d' & \frac{12{,}5\ =\ 8,}{35{,}35\ =\ 2{,}828} \end{array}$$

Example:—Suppose the lathe is regulated to turn a surface 24 inches diameter, what will be the number of turns of the long screw of the slide tool, and also the number of inches the tool will have moved, when the strap I arrives at each of the dotted lines *b′*, *c′*, and *d′*, (on the cone A and B,) the strap to commence at the dotted line *a′*, and the tool at the outside of the surface.



This will be best understood by referring to the annexed diagram. Let the largest circle *a″* represent the surface to be turned = 12 inches radius; the pinion 56 must be put in geer with the face wheel of 60 teeth, which is four times the diameter of the pinion; the bevel wheel 58 (on the bottom of the vertical axis 55) is double the diameter of the pinion 59; the smaller end of the fusee Q is only one-third of the larger end of the fusee P, and the larger end of the fusee Q is three times that of the smaller end of the fusee P; therefore, if the band be placed on the smaller end of the fusee Q, the velocity of the fusee P will be accelerated (when the tool moves from the outside of the surface towards the centre) nearly in a similar progression as the upper cone A is to the cone B; the fusees Q and P will each make about 11·8 turns to move the strap I from one end of the cones to the other; the number of turns that is required of the long screw of the slide tool to move the strap I from one end of the cones A and B to the other, will stand thus— 11·8 × 4 × 2 = 94·4 turns of the long screw; the distance between the circles *a″* and *d″* is 10·5 inches, which, multiplied by 9, (the number of turns in one inch of the screw,) will make 94·5, which will be equal to the number of turns required of the long screw of the slide tool to move the strap I from one end of the cones A and B to the other; the distance between the circles *a*″ and *b*″ is 6 inches, which is equal to 54 turns of the long screw; 54 turns of the screw will turn the fusee Q nine times round, the nine first turns of the fusee Q will only turn the fusee P four times round; the four turns of the fusee P will move the strap I (on the cones A and B) from the dotted line *a*′ to *b*′, by which means the velocity of the upper cone A, together with the lathe mandril, &c. will be doubled, (that is, supposing the cone B, &c. to have been previously put in motion) the tool will then have arrived at the circle *b*″, which is only one-half the diameter of the circle *a*″; but as the velocity of the lathe mandril is doubled, that part of the surface *b* will be passing the tool at the same velocity as when the tool was at the circle *a*″; the distance between circles *b*″ and *c*″ is three inches, which is equal to 27 turns of the long screw, and by turning the screw 27 times round, the fusee Q will be turned 4·5 times round; the strap I will be moved along the cones from the dotted line *b*′ to *c*′; the velocity of the upper cone A and the lathe mandril will again be doubled; the tool will have arrived at the circle *c*″, which is only one-fourth of the diameter of the circle *a*″; but as the velocity of the mandril is increased four to one, the surface will be passing the tool at the same velocity as at the commencement; the distance between the circles *c*″ and *d*″ is only 1·5 inch, which is equal 13·5 turns of the long screw of the slide tool; and by turning the screw 13·5 times round, the fusee Q will be turned 1·68 times, the fusee P will be turned 4 times; the strap I will be moved along the cones from the dotted line *c*′ to *d*′; the velocity of the upper cone A, together with the lathe mandril, &c.

will be doubled a third time; the tool will have arrived at the circle d'', which is only one-eighth of the diameter of the circle a''; but as the velocity of the lathe mandril, &c. is increased eight to one, the surface will have hitherto passed the tool always at the same velocity; the strap I will have arrived nearly at the end of the cones; the handle of the lever 60 must be turned towards the left hand, then the strap I will remain at the end of the cones till the tool has arrived at the centre of the surface. The chuck *v* contains four long screws; they are secured in their places by four collars, which act against the shoulder of the screws, and prevent any lateral motion of them; each collar is fixed in its place by two pins; there are four screwed nuts, which are well fitted in long parallel holes or openings made in the chuck, so as to slide to and fro without any shake; the back part of the holes is a little wider than the front; on the back part of the nuts is a flanch which projects on each side of the holes, and also rests against the back part of the chuck; the faces of the nuts are level with the face of the chuck; on the faces of the nuts are fixed, by four screws, flat plates or jaws, the edges of which are toothed like a file; the plates may be fixed across the holes if more convenient; there is also a number of dies or jaws of different shapes, which may be fixed to the nuts when required; the outer ends of the long screws are made square, to which is fitted a key for turning them round; therefore, if the screws are turned round in one direction, the nuts and dies will be forced towards the centre of the chuck, and will gripe or hold any thing that may be placed between them; but if the screws be turned in the contrary direction, the dies or jaws will be drawn towards the outer side of the chuck. This is a very convenient kind of chuck, for things may be fixed on it either concentric or excentric. There is a variety of other chucks fitted to the lathe, but not shewn in the engravings, which consist of the right and left-handed screw or universal chuck, right angle and bevel chuck, four and eight screwed box chuck, centre chuck, drill chuck, &c. 61 is an index or point, which is applied to the dividing plate on the face of the wheel W.

Fig. 5, Plate XI., is a vertical section of the index point, and fig. 6 a side view; they are drawn to double the size, as shewn in fig. 2. The index points that are commonly applied to dividing plates are fixed to the end of a spring and at right angles to it, the point commonly projects before the spring an inch, or an inch and a half, and when the point is placed in one of the holes in the dividing plate, a little strain or motion to turn the plate will cause the spring to bend in the middle, and will of course hold the dividing plate very imperfectly.

The index plate, as shewn in Plate XI., see fig. 5, consists of a small cylinder made to slide in a socket; there is a spiral spring placed on the middle part of the cylinder; one end of the spring acts against a shoulder in the socket, and the other against a shoulder on the cylinder, which pushes the point into one of the holes in the dividing plate; the point is withdrawn from the plate by the action of a lever; the socket is fixed in a hole made in the upper end of a piece of iron 62, which is about two inches by one, and which is strong enough to resist any strain that may be applied to the dividing plate without bending it; in the lower end of the piece 62 is a parallel hole, through which passes a screwed bolt 63. 64 is a bracket which is fixed to the side of the mandril frame by two screws; the head and neck of the bolt 63 is round, and well fitted in a hole made in the bracket 64; the middle part of the bolt 63 is made square, and fitted to the hole in the piece 62, so as to slide to and fro without any shake; there is also a washer fitted on the square part of the bolt, and against which acts the screwed nut 65. The piece 62, together with the bolts 63, &c. may be turned to and fro, so as to adjust the point 61 to any of the circles of holes on the dividing plate, and may be fixed in that position by the nut 65. There is also a tangent screw 66, the neck of which is fitted into a round hole made up the lower end of the piece 62, and is secured from any lateral motion by a pin which passes through a hole made in the piece 62, and also through a groove made in the neck of the screw 66; the screw also passes through a screwed hole in the square part of the bolt 63. There is a micrometer wheel fixed to the head of the screw 66, which is divided into 100 parts; the edge of the piece 62 (opposite the washer) is divided so as to point out each turn of the screw 66; therefore, the distance between any of the holes in the dividing plate may easily be subdivided, by first ascertaining the number of turns of the screw, and also the parts of a turn on the micrometer, and divide them by the number of divisions required between the holes of the dividing plate.

Fig. 1 *b*, Plate XI., is a section of the centre or poppet-head. Fig. 4 is a view of the centre end of the head; there is a cylindrical hole made through the upper part of the centre-head, into which is fitted a steel cylinder 70; in the right-hand end of the centre-head (see fig. 1 *b*) is sunk a hard steel collar, and driven in so tight as to prevent it from turning round; there is a round hole in the middle of the collar, in which is fitted the neck of a long screw 67. 68 is a gun-metal cap, which is screwed on the right-hand end of the centre-head; there is a round hole made in the middle of the cap, in which is fitted the outer end or neck of the screw 67; there is also a boss or shoulder on the screw, one end of which acts against the face of the collar, and the other against the inside of the cap 68; the cap may be screwed up so as to prevent any lateral motion of the screw 67: on the outer end of the screw is fitted a handle or winch 69; there is also a round hole made through the middle of the cylinder 70; the middle part of the hole is a little more in diameter than the outside of the thread of the screw 67; the hole in the right-hand end of the cylinder 70 is made smaller, and screwed so as to fit the screw 67; 71 is a large centre chuck, which is screwed into the left-hand end of the cylinder 70. Fig. 10 is also a centre chuck, into which are fitted smaller centres; there is a hole made a little conical through the middle of the chuck, into which is fitted one end of the centre, and, if driven lightly in, will prevent it from turning round: centres made in this way may be easily renewed or changed for a hollow centre.

Figs. 11 and 9 are two chucks, which may also be screwed into the end of the cylinder 70, the faces of which are for placing or holding any thing against to be drilled; 72 is a set screw, which is screwed through a hole made in the upper part of the centre-head; the lower part of the hole is made wider, to receive a piece of gun-metal which is fitted into it; the under side of the piece of gun-metal is fitted to the cylinder 70, and the end of the set- screw 72 acts against the upper side of it. The piece of gun-metal is to prevent the screws from injuring the cylinder; the use of the set screw is to fix the cylinder in any required position. There is a square groove made along the under-side of the cylinder 70; 73 is a pin which is driven into a hole made in the centre-head; the upper end of the pin 73 is made flat, and is fitted and also projects into the groove on the lower side of the cylinder; the pin is to prevent the cylinder from turning round; therefore, if the handle 69 of the screw be turned in one direction, the cylinder 70 will be forced out of the head, and if the handle of the screw be turned in the contrary direction, the cylinder will be withdrawn into the head, as shewn at fig. 1 *b;* 74 and 75 are screws and washers for fixing the centre and mandril-heads to the bed of the lathe.

No. XIII.

LEVER CRAMP.

The SILVER ISIS MEDAL was presented to Mr. ANDREW SMITH, 2, Palace Street, Pimlico, for his Lever Cramp; a Model of which has been placed in the Society's Repository.

THE object of the lever cramp is to furnish a powerful pressure, easy and convenient of application, for the purpose of bringing successively the boards employed in flooring rooms in close contact with each other previous to nailing them down. Several methods have heretofore been in use, which are either deficient in power, or cannot be applied without injuring the joists. Mr. Smith's